FAA-E-2503/1
June 1, 1976

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

BACKUP EMERGENCY COMMUNICATION

SYSTEM, VHF/UHF

FOREWORD

This specification consists of two parts as listed below:

Part 1 Backup Emergency Communication Transceivers, VHF/UHF

Part 2 Backup Emergency Communication Controller Station

PART 1 - BACKUP EMERGENCY COMMUNICATION TRANSCEIVERS, VHF/UHF

1-1. SCOPE

1-1.1 Scope.- The equipments covered by this specification are air/ground amplitude-modulated transceivers, either VHF or UHF, as specified in the contract schedule. They will be capable of 5-microvolt sensitivity, 20- to 40-watt output and 90 percent modulation with 25-kHz VHF and 50-kHz UHF channel spacing. These equipments will be used for emergency communications at FAA facilities.

1-1.1.1 System description.- The system which uses these transceivers will be operated by air route traffic control center (ARTCC) controllers through a high-speed, fast-response processor. The control equipment at controller stations consists of programable-processor and status-display equipments. The controller actuates the processing equipment to select, activate, frequency tune, and deactivate, or reset a given transceiver at a local or remote site.

1-1.2 Classification.- Two types of transceivers are specified herein, differing in performance requirements only with respect to the frequency of operation as follows:

VHF	118.00 to 135.975 MHz
UHF	225.00 to 399.95 MHz

1-2. APPLICABLE DOCUMENTS

1-2.1 FAA documents.- The following FAA specifications and standards of the issues specified in the invitation for bids or request for proposals, form a part of this specification and are applicable to the extent specified herein.

1-2.1.1 FAA specifications

FAA-E-163	Rack, Cabinet and Open Frame Types
FAA-G-2100/1	Electronic Equipment, General Requirements; Part 1, Basic Requirements for All Equipments
FAA-G-2100/3	Part 3, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-G-2100/5	Part 5, Requirements for Equipments Employing Microelectronic Circuits
FAA-D-2494/1	Technical Instruction Book Manuscripts: Electronic Equipment, Requirements for; Part I - Preparation of Manuscript
FAA-D-2494/2	Technical Instruction Book Manuscripts: Electronic, Electrical, and Mechanical Equipment, Requirements for: Part II - Preparation of Reproducible (Camera-Ready) Copy and Original Artwork
FAA-G-1210	Provisioning Technical Documentation

1-2.1.2 FAA standards

FAA-STD-002	Engineering Drawings
FAA-STD-012	Paint Systems for Equipment
FAA-STD-013	Quality Control Program Requirements

1-2.2 Military publications.- The following Military publications of the issues in effect on the date of the invitation for bids form a part of this specification.

1-2.2.1 Military specifications

MIL-E-17555	Electronics and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of
MIL-J-641	Jack, Telephone, General Specification for

MIL-R-10509 Resistor, Fixed, Film

1-2.2.2 Military standards

MIL-STD-470 Maintainability Program Requirements (For Systems and Equipments)

MIL-STD-471 Maintainability Verification/Demonstration/Evaluation

MIL-STD-721 Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety

MIL-STD-781 Reliability Tests: Exponential Distribution

MIL-STD-785 Reliability Program For Systems and Equipments Development and Production

1-2.2.3 Military handbooks

MIL-HDBK-217 Reliability Stress and Failure Rate Data for Electronic Equipment

MIL-HDBK-472 Maintainability Prediction

(Copies of this specification and other applicable FAA specifications and standards may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify material desired. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material.)

(Single copies of Military specifications, standards, and handbooks may be requested by mail or telephone from U.S. Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennslyvania 19120. For telephone requests call 215-697-3321, 8:00 a.m. to 4:30 p.m., Monday through Friday. Not more than five items may be ordered on a single request; the invitation for bid or contract number should be cited where applicable. Only latest revisions (complete with latest amendments) are available; slash sheets, such as MIL-E-1/305, must be individually requested. Request all items by document number.)

1-3. REQUIREMENTS

1-3.1 Equipment to be furnished by the contractor.- Each equipment furnished by the contractor shall be complete and in accordance with all specification requirements and shall include the items listed below. Instruction books shall be furnished in accordance with FAA-D-2494/1 and /2 and FAA-G-1210 in quantities specified in the contract schedule.

(a) Transceiver (1-3.2.16)

(b) Extender cables and/or cards (1-3.3.2.19)

(c) Mating RF connector (1-3.3.2.15, 1-3.3.2.16)

(d) Sliding rack-mounted tray kit (1-3.3.2.12)

(e) Detachable power cord (1-3.3.2.5.2)

1-3.1.1 Prototype requirements.- Insofar as the contract schedule requires one or more prototype equipments, these equipments shall meet all requirements of section 3 and the subparagraphs thereunder.

1-3.2 Definitions

1-3.2.1 Air traffic controller.- An air traffic controller is defined as the operator in the ARTCC who activates the backup selector to select an emergency air-to-ground transceiver in place of his RCAG outlet.

1-3.2.2 Ambient conditions.- The ambient conditions shall be those of Environment II (1-3.2.23 of FAA-G-2100/1) with the exception that temperature limits shall be -10° C to +60° C.

1-3.2.3 ARTCC.- ARTCC is defined as air route traffic control center.

1-3.2.4 Carrier power.- Carrier power, as used herein, is defined as the power in the carrier only, not including any power in the sideband frequencies which may be present.

1-3.2.5 Channel spacing.- Channel spacing for this specification is defined as 25 kHz for VHF and 50 kHz for UHF (1-3.3.1.1).

1-3.2.6 Channel tuning time.- Channel tuning time is defined as the time required to completely change the transceiver to a new channel after receiving a tuning word from the remote control system.

1-3.2.7 Compatibility.- Compatibility shall be defined as the ability of the transceiver to tune, reset, transmit, and receive per this specification.

1-3.2.8 Control adapter.- The control adapter is defined as an interface system which converts serial coded digital signals to the required logic signals which provide complete control of transceiver.

1-3.2.9 Frequency synthesizer.- A frequency synthesizer is defined as a device which derives selected output frequencies from a stable crystal-controlled fixed-frequency reference oscillator in response to control signals from the control adapter.

1-3.2.10 Hum distortion frequency.- Hum distortion frequency is defined as any frequency appearing in the demodulated RF output resulting from the combination of the signal frequency and the fundamental (or any harmonic) of the line supply frequency.

1-3.2.11 Message.- Message is defined as a series of digital coded signals which provide information to the control adapter for remote operation of the transceiver.

1-3.2.12 Power source.- The basic equipment power source shall be 120 V AC (1-3.2.21 and 1-3.2.23 of FAA-G-2100/1).

1-3.2.13 RCAG.- RCAG is defined as remote control air-to-ground facility.

1-3.2.14 Reset.- Reset defines the condition of a transceiver when it is shut down except for the control adapter and power supply awaiting another complete command message to place it in the receive condition.

1-3.2.15 Standard test voltage.- Standard test voltage is defined as an RF carrier 30 percent modulated at 1 kHz.

1-3.2.16 Transceiver.- A transceiver consists of a single unit, ready for installation and use, which contains the following items.

(a) Receiver (1-3.4.1)

(b) Transmitter (1-3.4.2)

(c) Synthesizer (1-3.4.3)

(d) Control adapter (1-3.4.4)

1-3.2.17 Voice grade line.- A voice grade line is defined as a four-wire 600-ohm ±40 percent voice line type 2001 series or equal with ±3 dB response or better between 300 Hz and 2600 Hz.

1-3.3 General requirements.- The equipment shall be built in conformance to FAA-G-2100/1, 3, 4, and 5.

1-3.3.1 Operational requirements.- Multichannel operation is required for the transceiver and it shall be remotely operated except for on-site maintenance.

1-3.3.1.1 Frequency range and channels.- The frequency range and channel spacing for each transceiver shall be as specified below. The system shall provide for selection of all of the channels one at a time, either UHF or VHF as required by contract.

Type	Frequency range	Channel spacing	Total channels
VHF	118.00 to 135.975 MHz	25 kHz	720
UHF	225.00 to 399.95 MHz	50 kHz	3,500

1-3.3.1.1.1 Optional channel spacing.- When required by the contract, the UHF channel spacing shall be 25 kHz, instead of 50 kHz, with a total

channel capacity of 7,000 channels. With this channel spacing requirement, the UHF selectivity requirement shall be the same as the VHF requirement (1-3.4.1.3).

1-3.3.1.2 Channel and frequency tuning.- All tuning to channel frequency shall be accomplished by the application of voltages through the control adapter to the synthesizer.

1-3.3.1.2.1 Local frequency selection.- Local frequency selection shall be provided on the front of the synthesizer for maintenance purposes only. The local selector shall provide direct indication of the frequency selected to the nearest 25 kHz or 50 kHz for VHF and UHF, respectively.

1-3.3.1.3 Tuning time.- The channel tuning time (1-3.2.6) shall not require more than 0.5 second when using remote control or local control. The transceiver shall be ready for use on the new channel after this period.

1-3.3.1.4 Remote control.- Serial digital remote control (over a four-wire voice grade line (1-3.2.17)) shall be employed for all control factors including channel selection.

1-3.3.1.5 Use of voice grade lines.- All signals, both control and voice, shall be carried over the same voice grade line (1-3.2.17).

1-3.3.1.6 Voice versus control signals.- The transceiver shall be so arranged that voice signals cause no erroneous control operation and control signals do not interfere in any way with voice transmissions. No control tones or harmonics greater than -20 dBm shall appear at the modulator input during transmitter operation. All control signals on the line during voice usage shall be operated within the bandpass of the voice channel, and the signals eliminated from the voice transmitting and receiving equipment by band elimination or notch filtering devices. Elimination of the extreme top or bottom of the allotted voice channel for signaling during voice transmission or reception shall not require elimination of more than 200 Hz at 3 dB points.

1-3.3.1.7 System compatibility.- The transceivers procured by this specification shall be fully compatible with the FAA equipment with which they are intended to operate. These equipments are the audio transfer panel, Type FA-8192, and a remote control processor (with its controller unit), Types FA-8195 and FA-8194.

1-3.3.1.8 System interface.- The interface audio frequency levels required for operation of the transceiver are as follows:

(a) The transceiver shall provide signal level to the receive pair of the voice grade line at +20 dBm minimum into a 600 ohm nominal load.

(b) The FAA input to the transceiver on the transmit line shall be capable of operation from -25 to +0 dBm from a balanced 600 ohm nominal source.

1-3.3.1.9 Stability.- Transceiver frequency accuracy and stability shall not exhibit transmitter output frequency error or a receiver IF output frequency error greater than ±5 Hz per MHz at channel frequency over the range of service conditions.

1-3.3.1.10 Colocation of two transceivers of the same type.- When a complete transceiver is transmitting and another transceiver is receiving, and the isolation between antenna connectors and frequency spacing is as specified in Table I below, the transmitting unit shall not cause the (S+N)/N (signal-plus-noise-to-noise ratio) to drop below the value shown in Table I. The (S+N)/N shall be measured with a standard test voltage of 10 microvolts (-93 dBm) at midband in normal service conditions. The transmitter shall be modulated 90 percent (20 watts carrier) with a 1-kHz 0-dBm signal. This requirement does not supersede 1-3.4.1.4 or 1-3.4.2.17.

TABLE I. ISOLATION/SIGNAL-TO-NOISE VS. FREQUENCY SPACING

Isolation (dB)	Spacing (MHz)	(S+N)/N (dB)
UHF		
52	0.6	0.7
	1.0	9
	1.5	12
	2.0	14
58	0.5	10
	1.0	12
	1.5	14
	2.0	16
VHF		
52	0.4	8
	1.0	11
	1.5	12
	2.0	13
58	0.25	10
	0.5	13
	1.0	15
	2.0	15

1-3.3.2 Construction.- The transceivers required under the contract shall be furnished as single complete units and must conform to drawings shown in figures 1 through 4. Modular plug-in construction shall be employed for ease of maintenance.

1-3.3.2.1 Front panel.- The front panel shall conform to the general layout shown in figure 5. The components listed below shall be symmetrically arranged on the panel as shown in the figure, designated as follows, and marked by silk screen method. The finish of the front panel shall conform to FAA-STD-012.

Component	Designation
Remote switch	MODE
AF gain control	AF GAIN
Power switch	ON/OFF
Pilot light	POWER (1-3.3.2.8)
Multimeter and switch	TEST (1-3.3.2.22 and 1-3.3.2.22.1)
RF output sampling jack	FWD PWR + -
Microphone jack	MICROPHONE INPUT
Phone jack	AF OUT
Nameplate	See 1-3.3.2.21
Synthesizer	SYNTH OUT (one for UHF, two for VHF)
Fuse	See FAA-G-2100/1
Squelch switch	SQUELCH ON/OFF
Test key switch	XMTR/KEYED
Modulation adjustment	MODULATION
Squelch adjustment	SQUELCH

1-3.3.2.2 Weight.- The unit shall weigh less than 75 pounds.

1-3.3.2.3 Chassis.- Each equipment shall be mounted in a rigid, wrap-around chassis. The equipment shall be designed to fit a standard 19-inch enclosed relay rack conforming to FAA-E-163.

1-3.3.2.3.1 Material.- All chassis material shall be 0.04 inch or thicker aluminum alloy.

1-3.3.2.3.2 Component mounting.- No active elements or controls shall protrude from the chassis. No panel or its controls shall protrude more than 5 inches beyond equipment mounting surface of the rack.

1-3.3.2.3.3 Depth behind mounting surface.- The maximum depth of the chassis from the equipment mounting surface shall be 16 inches. Connectors and heatsinks may be mounted on the rear surface. However, no item except cables shall protrude more than 2.5 inches behind the chassis.

1-3.3.2.3.4 Mechanical rigidity.- Mechanical rigidity shall permit no warpage of any assembly greater than 1/16 inch diagonally across corners when supported at each corner, one at a time, with access covers removed. This warpage shall not cause detuning of or damage to any circuits, or in any way deteriorate specified performance.

1-3.3.2.3.5 Cover.- A full dust-tight metal cover shall be furnished. Removal of the cover shall not require complete removal of any retaining screws or other fasteners.

1-3.3.2.4 Accessibility.- All necessary test points and adjustments or alignment controls necessary for operation of the transceiver other than those on the front panel shall become readily available with the cover (1-3.3.2.3.5) removed.

1-3.3.2.5 Power supply.- The transceiver shall operate directly from the 120 V AC power supply per FAA-G-2100/1.

1-3.3.2.5.1 Primary power switch.- A double-pole, single-throw switch shall be provided on the front panel of the transceiver. In the open or OFF position, all power to the unit shall be disconnected. In the closed or ON position, primary power shall be applied to the entire unit including its POWER indicating lamp and operation control circuits.

1-3.3.2.5.2 AC line receptacle and power cord.- An AC line receptacle (1-3.6.6 of FAA-G-2100/1) shall be mounted on the right rear of the transceiver chassis (as viewed from the rear). The detachable power cord shall be 30 inches long.

1-3.3.2.5.3 Power rectifiers.- Junction-type semiconductors shall be used. They shall be silicon, hermetically sealed, and shall be protected against power surge. Self-protecting controlled avalanche type rectifiers may be used to meet transient protection requirements (modifies 3-3.3, FAA-G-2100/3).

1-3.3.2.5.4 Power drain.- Maximum power drain shall not be greater than 550 watts on transmit and 250 watts on receive.

1-3-3-2-6 Line filter.- A power input RF filter may be connected between the input terminals and the line switch or circuit breaker (modifies 1-3.6.2 of FAA-G-2100/1).

1-3.3.2.7 Handles.- Handles shall be located on the front panel for support of the equipment during insertion into and removal from its mounting place. No interference with panel-mounted components or controls shall occur.

1-3.3.2.8 Indicator light.- The power indicator lamp shall be rated to have a minimum life, under rated conditions, of not less than 50,000 hours (1-3.16.5.1 of FAA-G-2100/1) and shall be a neon type with an amber cover.

1-3.3.2.9 Knobs and dials.- Fluted control knobs shall be provided for manual controls. Each of these controls shall have a calibrated scale on the front panel. As an exception of FAA-G-2100/1, knobs of other configurations than specified in FAA-G-2100/1 may be used provided metal inserts and at least two setscrews are used.

1-3.3.2.10 Tuning capacitors.- Mechanically-operated variable capacitors shall comply with 1-3.3.16.2 and 1-3.16.4.2 of FAA-G-2100/1.

1-3.3.2.11 Etched wiring.- Etched wiring boards may be used. Whenever etched wiring boards are used, the final product shall meet the requirements of FAA-G-2100/4 with the exception that multilayer boards shall be acceptable. In addition, paragraph 4-3.1.1 of FAA-G-2100/4 shall not apply and edge-type connector boards are acceptable.

1-3.3.2.12 Mounting. A sliding rack-mounted tray kit shall be supplied with each transceiver. It shall be able to totally support the transceiver when extended out from the cabinet.

1-3.3.2.13 Relays.- Mechanical relays shall not be used except in the activate function of the transceiver. All semiconductor relays shall display no less than 0.1 megohm leakage between all contacts or connections thereto. An electromechanical antenna T/R relay shall be furnished.

1-3.3.2.14 Intra-connections.- A complete set of intra-cables shall be provided for all circuits between components of the transceiver.

1-3.3.2.15 RF connections.- All intra-unit wiring for subassemblies utilizing coaxial cable for RF connections shall exhibit a characteristic impedence of 50 ohms. External connections shall be made via TNC-type connectors except for the antenna (1-3.3.2.16).

1-3.3.2.16 Antenna connector.- The antenna connector shall be a type N connector fed through a T/R switch mounted in the transceiver. The antenna connector shall be furnished with a mating connector which shall be a right-angled item.

1-3.3.2.17 Component boards.- All insulated component strips or boards (except etched wiring boards) used for mounting small components (1-3.14.5 of FAA-G-2100/1) shall be fabricated from materials in accordance with 1-3.15.3 of FAA-G-2100/1, with a minimum thickness of 1/16 inch. Terminal boards shall be rigid design and shall be mounted in such a manner that will render them suitable for repeated soldering and unsoldering of associated components without damage or loosening of the terminals, lugs, or studs.

1-3.3.2.18 Coils and coil forms.- Self-supporting coils shall be plated in accordance with 1-3.8.5.6 of FAA-G-2100/1. All coil forms shall be fabricated from ceramic materials and treated in accordance with 1-3.15.1 of FAA-G-2100/1. Mechanical locks or stops shall not be used on permeability-tuned coils.

1-3.3.2.19 Optional test extender cables and cards.- When required by the contract, extension card(s) (extension boards for maintenance of plug-in units) or cables shall be provided for any plug-in subassemblies which are removable for servicing.

1-3.3.2.20 Tie-points.- Tie-points used in inter-circuit wiring shall be fabricated in accordance with paragraph 1-3.14.5 of FAA-G-2100/1.

1-3.3.2.21 Nameplate.- Nameplates shall be provided in accordance with paragraph 1-3.13 of FAA-G-2100/1. The nameplates shall be titled as follows:

(a) VHF TRANSCEIVER, 20 WATT, FA-8191

(b) UHF TRANSCEIVER, 20 WATT, FA-8190

1-3.3.2.22 Multimeter.- A DC meter which is fully protected against burnout shall be provided. The meter range shall be such that, under normal test conditions, the needle deflection shall be from 5 to 95 percent of full scale for all positions of the meter transfer switch. Furthermore, during maintenance of the equipment, for all positions of the meter transfer switch, full-scale deflection shall not be exceeded. (Modifies 1-3.16.6.3, FAA-G-2100/1.) This meter shall have a round face.

1-3.3.2.22.1 Meter transfer switch.- A rotary type meter transfer switch (ceramic glass-fabric base epoxy resin, mica composition wafer, or phenolic wafer in accordance with 1-3.15.3 of FAA-G-2100/1) with a control knob shall be provided. Rotation of the transfer switch in a clockwise direction shall connect the meter to obtain successive readings, in sequence, with the voltage of each DC supply, and basic circuit checks required for maintenance of the transceiver. One position of this switch shall be marked OFF (no meter indication), one indicating a forward power, and one indicating a reverse power. All switch positions shall be adequately marked on the front panel so that each indication can be instantly identified. The multiplication factors of the position markings and ranges shall provide readily interpreted meter readings. The identification MULTIMETER SWITCH shall appear adjacent to the control knob.

1-3.3.2.22.2 Meter mounting.- The meter shall be mounted so as to be easily read during manipulation of all controls during maintenance and adjustment of the transceiver.

1-3.3.2.23 RF output.- A separate momentary-on switch shall be provided to key the transmitter when it is desired to read either forward or reverse power on the multimeter.

1-3.3.2.24 Meter multiplier and shunt resistors.- The use of fixed-film type resistors meeting the requirements of Specification MIL-R-10509 is also approved for multimeter multiplier and shunt resistors of 100 kilohms or less (modifies 1-3.16.6.8(d) of FAA-G-2100/1).

1-3.3.2.25 External circuit connector.- A barrier strip for handling all external circuits shall be mounted on the left rear of the chassis as viewed from the rear.

1-3.3.2.26 Interlock bypass switches.- Interlock bypass switches are not required.

1-3.3.2.27 Solid-state design.- The use of semiconductors (diodes and transistors) instead of electron tubes is required for all circuit applications.

1-3.3.2.27.1 Semiconductor devices.- All semiconductor devices shall be of the silicon type. Connections to semiconductors shall be soldered except where stud mounting terminals are provided thereon (3-3.2 of FAA-G-2100/3).

1-3.3.2.27.2 Derating of semiconductors.- Semiconductor derating shall comply with 1-3.4.7 of FAA-G-2100/1.

1-3.3.3 Reliability program.- A reliability program plan, in accordance with MIL-STD-785 and FAA-E-2100/1, shall be submitted to the FAA as specified in the contract.

1-3.3.3.1 Mean time between failures (MTBF).- The required reliability shall be reflected in an MTBF of 15,000 hours for each transceiver with a 1:1 duty cycle of transmit to receive as calculated per MIL-HDBK-217.

1-3.3.3.1.1 Reliability prediction report.- A reliability prediction report shall be available at the preliminary design review for review and comment. All definitions shall agree with MIL-STD-721. Reliability prediction shall be based on MIL-HDBK-217 and shall contain information in accordance with section 5 and section 7. All failure rate data shall be presented in module failure per 10^6 hours. All predictions shall be based on ambient temperature of 30^0 C. Particular consideration should be given to thermal design aspects as contained in section 6. Parts not included in the coverage of MIL-HDBK-217 shall be assumed to possess the failure rate of the most similar part in the coverage. Where this is unrealistic, any valid existing data may be used, subject to Government acceptance. A preliminary prediction shall be submitted with the proposal.

1-3.3.3.1.2 Reliability prediction report update.- An updated reliability prediction report shall be submitted as the design changes. A final report shall be submitted previous to first acceptance testing/reliability testing of equipment hardware.

1-3.3.3.2 Parts control (selection and application).- The contractor shall use parts selected from and supplied as specified in FAA-G-2100/1. Parts not meeting requirements of FAA-G-2100/1 are non-standard parts which require actions as outlined in paragraph 5.2.3 of MIL-STD-785. Failure rate levels shall be provided by the contractor with justification for all parts including non-standard parts not covered by MIL-HDBK-217.

1-3.3.3.3 Reliability demonstration test plan and procedure.- A reliability demonstration test plan and procedure delineating a reliability demonstration test in detail, shall be submitted for approval prior to conducting a demonstrated test. The test plans contained in MIL-STD-781 shall be applied, when applicable. Any other reliability test plans proposed shall be detailed with regard to sample size, duration of test confidence level, conditions of test, accept/reject criteria, etc. A specific test plan and test level may be specified in the contract.

1-3.3.3.3.1 Failure classification.- For purposes of the reliability demonstration testing, a relevant failure is an unpredictable occurrence wherein the equipment under test failed to perform its required function within the previously established limits, or any condition that produces an alarm, or any malfunction whatsoever.

1-3.3.3.3.2 Multiple failures.- In the event two or more part failures are detected in the equipment being tested, and one or more of these part failures are the primary cause of the test malfunction, each failed part which will independently prevent satisfactory equipment performance is considered a failure, except as follows: If it is determined that the failure of one part was responsible for the failure of another part then each secondary part failure is not counted as an equipment failure when the accept/reject criteria is applied.

1-3.3.3.3.3 Non-relevant failures.- Failures classifed as non-relevant are identified below. Failures identified as non-relevant will be subject to review by FAA.

1-3.3.3.3.3.1 Failures caused by external sources.- All failures caused by sources external to the equipment under test will be considered non-relevant. This includes failures caused by operator error, test equipment malfunction, and test facility malfunction.

1-3.3.3.3.3.2 Secondary failure.- A secondary failure is the failure of a part which is a direct result of a primary failure. Secondary failures are not necessarily present when simultaneous failures occur. Secondary failures will be considered non-relevant.

1-3.3.3.3.4 Analysis of failures.- All equipment failures will be analyzed. The objective is to provide a critical examination of all failures and failure modes to determine the cause and recommend corrective action to reduce causes of unreliability. Failures will be reviewed at the equipment level to assure proper part application (i.e., thermal, electrical overstress, and mechanical stresses as possible cause of failure). Failures will be analyzed at the component/part level. Analysis will include verification, laboratory analysis, teardown, dissection, and X-ray, as required.

1-3.3.4 Maintainability program.- A maintainability program plan in accordance with MIL-STD-470 and FAA-E-2100/1 shall be submitted to the Government as specified in the contract.

1-3.3.4.1 Maintainability prediction report.- A maintainability prediction report shall be prepared in accordance with MIL-HDBK-472, Procedure II, and shall be available at the preliminary design review. A preliminary prediction shall be submitted with the proposal.

1-3.3.4.2 Maintainability design criteria.- The contractor shall establish and periodically update a detailed maintainability design criteria determined from the repetitive system/equipment maintainability analysis. Appropriate consideration of maintainability design criteria shall be reflected in design concept reviews, item selection, design reviews, and trade-offs.

1-3.3.4.2.1 Mean time to repair (MTTR).- The MTTR of the transceiver shall not be greater than 5 minutes for 95 percent of the maintenance tasks. No single repair shall require in excess of 2 hours.

1-3.3.4.2.2 Preventive maintenance.- Preventive maintenance schedules shall be provided. Particular consideration shall be given to those parts that exhibit an increased failure rate with time. The parts selected for use in the equipments shall exhibit a very high reliability to preclude the necessity of an excessive or time-consuming preventive maintenance schedule.

1-3.3.4.3 Maintainability demonstration plan.- The contractor shall prepare and submit a maintainability demonstration plan. The demonstration will be accomplished in accordance with MIL-STD-471 and will verify the acheivement of the maintainability requirements by the hardware design.

1-3.3.5 Preliminary design review.- The contractor shall hold a preliminary design review with representitives of the Government present prior to the fabrication of any equipment. The preliminary design review shall include the configuration of all chassis and panels, preliminary reliability

prediction report, preliminary maintainability design criteria, and preliminary engineering drawings per FAA-STD-002. An electronic complement report shall be submitted and include all semiconductor devices to be used in the equipment with full operating data at 0° C, at 25° C, and at 60° C.

1-3.4 Detailed Requirements

1-3.4.1 Receiver requirements.- This portion of the specification contains those requirements which are applicable to the receiving portion of the transceiver and are to be met operating with the synthesizer unless otherwise noted herein.

1-3.4.1.1 General.- The receiver portion of the transceiver shall be a solid-state superheterodyne. The VHF transceiver shall be a single conversion superheterodyne with an intermediate frequency of 20.6 MHz. The UHF transceiver shall be a double conversion superheterodyne with intermediate frequencies of 55 MHz and 20.6 MHz.

1-3.4.1.1.1 Remote control.- Remote control of the receiver shall be accomplished through the control adapter. The control adapter shall provide signals to the synthesizer to generate a frequency source for the receive functions of the transceiver.

1-3.4.1.1.1.1 Channel selection.- Receiver channel selection shall be accomplished through the control adapter which shall provide logic signals needed for remote receiver operation.

1-3.4.1.1.2 RF input circuit.- The antenna input circuit shall be designed for connection to a 50-ohm unbalanced flexible coaxial cable.

1-3.4.1.1.3 IF adjustments.- The IF amplifier shall be preadjusted and shall not require field adjustment at any time unless IF components are replaced during maintenance.

1-3.4.1.2 Sensitivity.- Under all test conditions, a standard test voltage of 5.0 microvolts into the transceiver with the squelch in operation shall produce rated output (1-3.4.1.12) for a 10 dB (minimum) signal-plus-noise to-noise ratio at the receiver output. Further, over the range of service conditions, the audio output at the receiver output terminals shall not be less than 0.1 watt using a standard test voltage not to exceed 10 microvolts.

1-3.4.1.3 Selectivity.- The bandwidth corresponding to off-channel attenuation shall conform to the following limits with respect to the design center frequency of the output intermediate frequency amplifier. The selectivity performance of each equipment shall be demonstrated to provide response shown for its type. Each reciever delivered shall be equipped for whichever bandwidth is required for its type.

Attenuation	VHF	UHF
6 dB	±9 kHz minimum	±18 kHz minimum
20 dB	±15 kHz maximum	±28 kHz maximum
40 dB	±18 kHz maximum	±32 kHz maximum
60 dB	±21 kHz maximum	±36 kHz maximum
80 dB	±25 kHz maximum	±40 kHz maximum

1-3.4.1.3.1 Passband characteristics.- The decrease in amplitude between multiple response peaks in the selectivity characteristics shall not exceed 4 dB below the point of maximum response.

1-3.4.1.4 Undesired RF responses.- The off-channel frequency response shall be greater than 80 dB below the channel frequency response for frequencies between ±100 kHz and ±350 kHz for VHF receivers, and between ±100 kHz and ±900 kHz for UHF receivers. The off-channel response shall be greater than 90 dB below the channel response for frequencies greater than ±350 kHz for VHF receivers, or greater than ±900 kHz for UHF receivers. VHF image shall be 80 dB down while UHF image shall be 60 dB down, each referred to center frequency response. No more than six each of extremely narrow highly peaked responses, each not over 0.1 MHz wide, at 90 dB shall be permitted and shall show not less than 70 dB response at the peak.

1-3.4.1.4.1 Desensitization due to strong RF signals.- With a standard channel test voltage of 5.0 microvolts producing 0.1 watt into the audio output load, the following high-level, off-resonance (off-channel), unmodulated signals (undesired) shall not reduce the receiver output more than 3 dB nor shall the (S+N)/N ratio be less than shown below:

Undesired level Volts (open circuit)	(S+N)/N ratios VHF ±MHz off resonance 3 dB	5 dB	10 dB	UHF ±MHz off resonance 3 dB	5 dB	10 dB
0.05	0.1	0.2	0.3	1.0	1.2	1.8
0.10	0.2	0.4	0.6	1.4	2.0	2.6
0.30	0.45	0.9	1.8	2.0	2.5	3.3

1-3.4.1.4.2 Cross-modulation.- With the receiver gain controls set so that a channel standard test voltage of 5.0 microvolts will produce 0.1 watt into the audio output load with a 10 dB (minimum) signal-plus-noise-to-noise ratio, the simultaneous application of 90 percent modulated off resonant signal (undesired) and unmodulated resonant signal (desired) shall produce an audio output (S+N)/N ratio less than 6 dB for values tabulated below when N = noise residue of unmodulated desired signal and S = signal resulting from 90 percent modulated undesired signal. At frequency spacings greater than ±2.0 MHz VHF and ±6.0 MHz UHF, an undesired signal of 1.0 V shall provide cross-modulation (S+N)/N products less than 2 dB.

	(S+N)/N ratios	
Undesired level volts (open circuit)	VHF ±MHz off resonance	UHF ±MHz off resonance
0.1	0.40	1.25
0.3	0.80	2.40
0.6	1.00	4.00
1.0	2.00	6.00

1-3.4.1.4.3 RF intermodulation.- With the receiver gain controls set so that a standard test voltage of 5.0 microvolts at resonance (f_o) will produce 20 dBm into the audio output load, the simultaneous application of two off-resonance signals (f_a and f_b) of not less than 20,000 microvolts each for VHF and 5,000 microvolts each for UHF, in place of the standard test voltage, shall be required to produce an audio output of 13 dBm. The two off-resonance signals shall be spaced 100 kHz from each other with f_a ±100 kHz from f_o and so related that $f_o = 2 f_a - f_b$. The carrier amplitude of the off-resonance signals shall be equal to each other. Signal f_a shall be unmodulated and signal f_b shall be modulated 30 percent at 1000 Hz.

1-3.4.1.5 Automatic volume control (AVC).- The receiver output shall not vary more than 3 dB with standard test voltages in the range of 5 microvolts to 1.0 volt. Variation of percentage modulation over the range zero to 90 percent at all RF voltages over the range 10 microvolts to 1.0 volt shall not affect the AVC voltage more than 1 percent.

1-3.4.1.5.1 AVC time constant.- Charge time constant of the AVC system shall not exceed 0.10 second. The discharge time constant shall not exceed 0.50 second. (The time constant is the time required to reach two-thirds of its final value.)

1-3.4.1.6 Squelch, general functions.- A carrier-operated noise silencer meeting the requirements of the following subparagraphs shall be provided to mute the receiver output. The carrier-operated squelch shall be adjustable by internal control to set the squelch operating point from no signal to not less than 10 microvolts input.

1-3.4.1.6.1 Differential.- The RF input signal voltages required to open and to close the squelch shall have a ratio not to exceed 2 to 1.

1-3.4.1.6.2 Opening time.- Operation of the squelch circuit by the application of a standard test voltage shall occur within a period of time not exceeding the charge time constant of the AVC circuit by more than 0.05 second.

1-3.4.1.6.3 Muting.- Receiver muting shall be accomplished with the relay specified in subparagraph 1-3.4.1.6.4 so that no partially muted condition can occur. The receiver output shall be attenuated not less than 40 dB when the squelch relay is operated.

1-3.4.1.6.4 Relay.- Solid-state relays (switches) shall have a life expectancy of 20 million operations. Isolation between contact shall not be less than 0.1 megohm when in unoperated state. The relay shall be in the unoperated state with the squelch open.

1-3.4.1.6.5 Switch.- A switch shall be provided for rendering the squelch inoperative when the switch is in the OFF (lower) position; the squelch shall be ON, or operative, in the upper position.

1-3.4.1.7 Noise control.- A noise control system shall be incorporated in the receiver to reduce impluse type noise.

1-3.4.1.8 Conductance susceptibility.- Adjust the receiver gain so that a standard test voltage of 5.0 microvolts will produce 0.1 watt output into the output load. Remove this signal and terminate the input with a 50-ohm resistor. A standard test voltage of 1,000 microvolts at the channel frequency and 100,000 microvolts at all other frequencies from 1 MHz to 1 GHz, removed 0.5 MHz and more from the channel frequency, shall be applied to the audio output and each other external connection point, including the power receptacle by excluding the RF input connector. This signal shall not produce more than 10 milliwatts of audio power into the audio load. The 1,000 microvolt test voltage shall be capacitively coupled through not less than 1,000 pF to the receiver connection points and chassis.

1-3.4.1.9 Mixer/synthesizer coupled output.- Oscillator, synthesizer, or oscillator harmonics, and all other spurious outputs shall not exceed 140 microvolts as measured at the antenna receptacle terminated into 50 ohms.

1-3.4.1.10 Multiple mixer interaction.- When multiple frequency conversion is used, sufficient isolation and shielding shall be incorporated to insure that all output due to heterodyning of the local frequencies, or any combinations of the harmonics from them both, with and without an incoming signal, are down 20 dB or more, referred to the output produced by a standard test voltage of 5.0 microvolts and to insure that the squelch does not open due to such heterodyning.

1-3.4.1.11 Channel frequency accuracy and stability.- Normal test conditions shall apply to each subparagraph hereunder except as otherwise specified. The requirements of this paragraph and its subparagraphs apply to the accuracy and stability of frequency conversion in the receiver. For the purpose of these requirements, measurements shall apply at the output of the basic frequency selective IF amplifier without considering final conversion when the final IF amplifier does not contribute to the selectivity requirements herein.

1-3.4.1.11.1 Initial conditions.- The following conditions shall apply to all frequency accuracy and stability requirements hereof. The receiver shall be aligned following the instruction book alignment procedures. Frequency measuring equipment shall not be used during this alignment. After initial alignment, an unmodulated test voltage at the specified channel frequency shall be applied but no further adjustments shall be made.

1-3.4.1.11.2 IF output frequency.- Over the range of all service conditions the output frequency of the IF amplifier at any and all input channel frequencies shall not vary more than 5 parts per MHz of input frequency, including all effects of detuning any manually adjusted circuit of the reciever.

1-3.4.1.12 Rated AF output.- Rated AF output shall be 0.1 watt minimum into a 600 ±60 ohm resistive audio output load.

1-3.4.1.13 AF gain control.- An AF gain control shall be included which shall provide 40 dB reduction in AF output referred to rated output, linear, ±10 percent with rotation in degrees over its full range.

1-3.4.1.14 Audio frequency response.- With a standard test voltage producing 0.05 watt output into the main output load at 1 kHz, the power input into the audio load shall not vary more than +1 and -3 dB relative to the response at 1 kHz over the range of 300 Hz to 3 kHz. The gain at frequencies above 3 kHz shall continuously decrease as input frequency increases. The gain at frequencies below 300 Hz shall decrease as input frequency decreases.

1-3.4.1.14.1 Harmonic distortion.- With 0.1 volt standard test voltage, modulated at all frequencies successively in the range 300 Hz to 3 kHz, applied to the receiver input and with the gain adjusted to produce 0.1 watt output into a 600 ohm load, the total harmonic distortion over the range 300 Hz to 3 kHz shall not exceed 10 percent with 30 percent modulation; the distortion with 90 percent modulation shall not exceed 15 percent. The same requirements shall be met with the AF gain adjusted to provide 0.01 watt into the audio output load (1-3.4.1.12).

1-3.4.1.14.2 Hum and noise.- With standard test voltages of 300 microvolts to 0.1 volt applied to the receiver input, the hum and all other extraneous signals, including hum modulation of 1 kHz tone delivered to the output load, shall be down 35 dB or more referred to a 1 kHz output level of 0.1 watt.

1-3.4.1.15 Output circuits.- A balanced ungrounded transformer output circuit shall be provided. The output shall deliver not less than 0.1 watt into the audio output load (1-3.4.1.12). The variation in output level shall be provided by an AF gain control (1-3.4.1.13). The output transformer secondary shall consist of one winding which shall be isolated from ground and shall connect directly to the output circuit connector.

1-3.4.1.15.1 Output level regulation.- With an initial output of 0.1 watt into the audio output load (1-3.4.1.12), the output voltage shall not drop more than 35 percent for a 5 to 1 reduction in the load resistance (1-3.4.1.12).

1-3.4.1.15.2 Audio level vs. modulation.- With a standard test voltage of 15 microvolts and the receiver adjusted to produce up to 0.1 watt into the output load, the output shall not increase more than 3 dB when the modulation is increased to 90 percent.

1-3.4.1.15.3 Output level stability.- With a standard test voltage of 100 microvolts and with the gain adjusted to produce 0.1 watt into the output load under normal conditions, the output shall not vary more than 2 dB with a line voltage variation from 105 to 130 volts at normal room temperature and humidity and not more than 2 dB due to variation in temperature and humidity over the ranges specified for the service conditions with a line voltage of 120 volts.

1-3.4.1.15.4 Silencing.- The receiver shall be turned off when the transceiver is transmitting. This function shall be controlled from the press-to-talk control circuits.

1-3.4.1.16 Circuit protection.- In addition to the requirements of paragraph 1-3.7 and subparagraphs of FAA-G-2100/1, circuit protection shall be provided in accordance with the following subparagraph.

1-3.4.1.16.1 RF input circuit.- The receiver shall withstand without permanent damage or permanent change of sensitivity or gain, at 255 MHz and at 399.95 MHz for the UHF receiver or at 118 MHz and at 136 MHz for the VHF receiver, a channel input voltage of 4.0 V unmodulated applied to the RF input circuit continuously for 5 minutes.

1-3.4.1.17 Operational stability.- The receiver shall be free of all traces of heterodyning of RF or AF regeneration, including radar, which may appear in such forms as squealing, motorboating, and other instabilities, either audible or inaudible.

1-3.4.1.18 Phone jack.- One audio jack that conforms to MIL-J-641 and accepts a PJ-055 plug shall be mounted on the front panel.

1-3.4.2 Transmitter requirements.- This section of the specification contains those requirements which are applicable to the transmitting portion of the transceiver. These requirements must be met using the synthesizer except as noted herein.

1-3.4.2.1 Band width and tuning.- The transmitter shall be broad band and the synthesizer shall provide channel tuning.

1-3.4.2.2 Freedom of parasitic and spurious oscillations.- Under all combinations of the following conditions there shall be no parasitic or spurious oscillations:

(a) All manual tuning or coupling controls of any stage adjusted through all positions regardless of transmitter power output.

(b) Modulator gain control adjusted for any specified modulation percentage of 10 to 95 percent inclusive and at any and all audio frequencies

(c) RF drive and AGC controls adjusted from zero to full output positions in any combinations.

(d) At all output circuits operating into loads causing a voltage standing wave ratio of 1.0 to 3.0

1-3.4.2.3 Reserve excitation.- Under normal test conditions with the equipment adjusted in accordance with the instruction book procedures, there shall be sufficient excitation so that normal transmitter output is available.

1-3.4.2.4 Frequency multiplication.- No frequency multiplication shall occur following injection of channel frequency from the synthesizer.

1-3.4.2.5 Carrier control.- The output carrier shall reach full amplitude in not more than 240 ms after the keying tone is activated and zero amplitude in not more than 240 ms after key tone is released.

1-3.4.2.5.1 Voltage SWR protection.- Automatic high voltage SWR (standing wave ratio) shall be provided for SWR values above which transmitter components can be damaged.

1-3.4.2.5.2 Keying.- Keying shall be controlled through the control adapter through an in-band keying tone of 2423 Hz ±5 Hz.

1-3.4.2.6 Output frequency accuracy and stability.- Frequency accuracy and stability shall meet the requirements of 1-3.3.1.9 and the following subparagraphs.

1-3.4.2.6.1 Initial conditions.- The following conditions shall apply to all frequency accuracy and stability requirements herein. The equipment shall be tuned under normal test conditions. No frequency measuring equipment shall be used in initial tuneup. After initial tuneup, the frequency shall be measured but no further adjustments shall be made to controls unless specifically allowed hereinafter.

1-3.4.2.6.2 RF output frequency.- Each RF output channel frequency shall remain within five parts per megahertz of channel assignment over the range of service conditions including detuning of any circuit of the transmitter and regardless of modulation depth or any RF system adjustment.

1-3.4.2.7 RF output stabilization.- A feedback from the output circuit of the final RF amplifier shall be used to stabilize the operation of RF output amplifiers.

1-3.4.2.8 Output circuit.- The transmitter shall be designed for operation into a 50-ohm unbalanced coaxial cable. The design shall include means for coupling to the coaxial cable for all values of standing wave ratio up to 3, throughout the entire range of impedence angles, both negative and positive, and for all values of carrier output power for adjustment of the carrier power output. The output circuit and all following circuits including the RF output connector shall be at DC ground potential except for RF voltages produced by the transmitter (1-3.5.9.1 of FAA-G-2100/1). Maintenance adjustment of output coupling, when provided, shall be easily accessible.

1-3.4.2.9 RF output sampling circuit.- An RF output sampling circuit shall be included to facilitate checking of relative RF power output and modulation as well as to provide a means for observing and measuring components of the audio waveform. The sampling voltage shall be taken immediately following the output circuit. Rectified output shall be available via the multimeter on the panel. The RF sampling circuit shall supply a suitable voltage to the meter circuits with the carrier modulated 90 percent under rated circuit power and 50-ohm resistive load. Tuning of the transmitter shall not be affected by the sampling circuit termination.

1-3.4.2.10 Derating of transmitter semiconductors.- For carrier power output and modulation requirements, the following conditions shall apply: no

semiconductors shall be required to operate any of their elements at currents or voltages higher than allowed for continuous commercial service (CCS) in the manufacturer's published rating for the type of service and frequencies involved. The power dissipation in any element for all semiconductors shall not exceed the following limits for the type of service and frequencies involved:

Component	Line voltage	Percent of maximum published CCS ratings
Power amplifier	130	80
All other semiconductors	120	80
All other semiconductors	130	100

1-3.4.2.11 RF chokes.- The circuit design shall be such that RF chokes are not required. Chokes shall not be installed where their use can be avoided by proper control of assembly methods and techniques.

1-3.4.2.12 Rated carrier power level.- The unmodulated RF carrier output shall be capable of operation from 20 W to 40 W into an unbalanced 50-ohm resistive load over the entire frequency range of either VHF or UHF transceivers. Unless otherwise specified, all requirements shall be met at this carrier output and load (with 90 percent modulation where required). (See 1-3.4.2.20.3.)

1-3.4.2.13 Carrier power output stability.- At 90 percent modulation, the carrier output level decrease (from the level under normal test conditions) shall not drop below the values specified in the following subparagraphs.

1-3.4.2.13.1 Effect of temperature and humidity.- The carrier power output variation shall not decrease below 20 W throughout the ranges of temperature and humidity specified in the service conditions (line voltage maintained at 120 V).

1-3.4.2.13.2 Effect of the line voltage variation.- The carrier output level variation shall not decrease below 20 W throughout the range of line voltages specified in the service conditions (other conditions normal).

1-3.4.2.14 Carrier level variation.- The carrier level shall not decrease below 20 W as a result of modulation changes from zero to all values up to 90 percent.

1-3.4.2.15 Carrier noise.- The amplitude of the carrier noise (including hum modulation) shall not exceed a value corresponding to 40 dB below 90 percent modulation.

1-3.4.2.15.1 Harmonic and spurious output.- The level of each spurious frequency at the transmitter output connector up to 1 GHz, for all percentages of modulation up to 90 percent, shall be down not less than 80 dB referred to the level of the carrier fundamental; carrier harmonics similarly shall be down not less than 60 dB.

1-3.4.2.16 Radiated and conducted noise interference.- In order to minimize all radiated and conducted noise interference in the frequency range 25 MHz to 1 GHz which may be radiated directly from or conducted on external

leads from the equipment, suitable shielding or filtering or both shall be provided for all RF circuits and for all leads (other than the RF connectors) entering RF compartments.

1-3.4.2.17 Undesired radiation level.- The induced voltage in a half-wave test antenna shall not exceed the limits stated below when measured at a distance of 4 feet to the center of the test antenna from the nearest perimeter of the transceiver and from unshielded leads not less than 4 feet long connected to all terminals except the antenna terminals provided for external connections.

Frequency	Level
25 to 440 MHz (except carrier frequency)	37 dB above 1 μV
440 MHz to 1 GHz	42 dB above 1 μV
Carrier frequency with 90% modulation	92 dB above 1 μV

1-3.4.2.18 RF intermodulation (VHF).- In carrier ON condition, the amplitude of each RF intermodulation product shall be down not less than 25 dB referred to the rated carrier level, when the interfering signal is down 20 dB referred to the transmitter rated output level (1-3.4.2.12), spaced ±500 kHz from the transmitter output frequency, and fed into the transmitter output connector.

1-3.4.2.19 RF intermodulation (UHF).- In carrier ON condition the amplitude of each RF intermodulation product shall be down not less than 30 dB referred to the rated carrier output when the interfering signal is down 20 dB referred to the transmitter rated output level, spaced at ±1.0 MHz from the transmitter output frequency, and fed into the transmitter output connector.

1-3.4.2.20 Modulation

1-3.4.2.20.1 Type of modulation.- Amplitude modulation shall be provided.

1-3.4.2.20.2 Application of input voltage.- Audio frequency input voltage shall be applied through an external noninductive series resistor equal in value (within ±1%) to the normal input impedance. The input level at the input terminals of the amplifier, used in gain calculations, shall be taken as E_1 calculated from the formula below after measuring E. In no case shall a measured value of E_1 be used in calculations as to the input to the amplifier.

E = Signal source voltage, applied through series resistor R where R is equal to the nominal impedance of the input

E_1 = Voltage input to amplifier

P_1 = Power input to amplifier

$$E_1 = \frac{E}{2} \qquad P_1 = \frac{E^2}{4R}$$

1-3.4.2.20.3 Modulation range.- The modulation of the carrier shall be adjustable to all percentages from 10 percent to not less than 90 percent.

1-3.4.2.20.4 Modulation percentage stability.- The modulation percentage shall not vary more than ±10% (from the percentage under normal test

conditions) throughout the range of line voltage specified in the service conditions (other conditions normal).

1-3.4.2.21 Transmitter input.- The transmitter shall meet the specification requirements at all audio input levels from -25 dBm to 0 dBm and at all audio frequencies in the range 300 Hz to 3 kHz.

1-3.4.2.21.1 Transmitter input circuit.- The audio input to the transmitter shall be connected directly to an ungrounded transformer primary which shall present a balanced input to the line (1-3.2.17).

1-3.4.2.21.1.1 Input impedance.- At all frequencies in the range 300 Hz to 3 kHz, the input impedance of primary winding shall be 600 ohms ±60 ohms.

1-3.4.2.21.1.2 Gain control.- The transmitter shall be provided with a gain control. The control shall be mounted on the front panel. The gain control shall be a continuously adjustable resistor type with a linear taper. The gain control shall be connected to provide an increase in modulation as its shaft is rotated in a clockwise direction.

1-3.4.2.21.2 Audio response.- With a constant input amplitude, the audio response shall be in accordance with the following subparagraphs at all percentages of modulation up to 90 percent.

1-3.4.2.21.2.1 Response below 300 Hz.- At frequencies below 300 Hz, the modulation amplitude in the output shall decrease as the frequency is decreased.

1-3.4.2.21.2.2 Response, 300 Hz to 3 kHz.- Throughout the range of 300 Hz to 3 kHz, the modulation amplitude shall not vary more than +1 or -3 dB referred to the modulation amplitude at 1 kHz.

1-3.4.2.21.2.3 Response above 3 kHz.- At frequencies above 3 kHz, the modulation amplitude shall decrease as the frequency is increased, and shall be down not less than 10 dB at 10 kHz referred to the modulation amplitude at 1 kHz.

1-3.4.2.21.3 Audio distortion.- At rated carrier power output, with all percentages of modulation up to 90 percent, and all modulating frequencies between 300 Hz and 3 kHz, the total harmonic distortion in the demodulated transmitter output shall not exceed 10 percent.

1-3.4.2.21.3.1 Hum distortion.- At all percentages of modulation up to 90 percent, the root sum square of the amplitudes of all hum distortion frequencies shall be down not less than 40 dB referred to the amplitude of the modulating frequency.

1-3.4.2.22 Keying.- The keying relay shall be DC-operated to eliminate possibility of eventual hum and noise.

1-3.4.3 Synthesizer requirements.- This section contains those requirements which are applicable to the synthesizer portion of the transceiver.

1-3.4.3.1 General.- The synthesizer shall provide the output signals listed in the following paragraphs upon receipt of correctly coded control signals from the control adapter.

1-3.4.3.1.1 Frequency outputs.- The synthesizer outputs shall provide the operating channels specified in 1-1.2 and 1-3.3.1.1 for the transceiver in accordance with paragraph 1-3.4.3.2 and its subparagraphs.

1-3.4.3.2 Output requirements.- Synthesizer outputs shall be compatible with receiver and transmitter requirements for frequency determination and passive circuit determination and shall meet the requirements of the following subparagraphs.

1-3.4.3.2.1 Available frequencies.- RF power outputs required for both the receiver local oscillator and the transmitter drive shall be made available out of the synthesizer.

1-3.4.3.2.2 Fail-safe.- The RF output of the synthesizer shall lock on frequency or provide a signal showing incorrect operation.

1-3.4.3.2.2.1 Non-lock signal.- The synthesizer shall provide means for return of a signal to the control site (ARTCC), through the control adapter, to show non-lock or other incorrect operation.

1-3.4.3.2.3 Frequency accuracy.- The accuracy of any and all output frequencies shall satisfy the requirements of 1-3.3.1.9 over the range of service conditions.

1-3.4.3.2.4 Output levels.- RF output levels shall be compatible with intended application but shall not be greater than 0.05 watt or less the .001 watt.

1-3.4.3.2.4.1 Spurious outputs.- Harmonic outputs shall be at least 60 dB below the fundamental output. All non-harmonic outputs shall be at least 100 dB below the fundamental output. Random noise shall be at least 90 dB below the fundamental output. Noise bandwidth shall be limited to 30 kHz.

1-3.4.3.3 Ready signal.- At the completion of all operations required to prepare the transceiver for receive condition, in the absence of a non-tune signal, an 1800 Hz signal shall be returned to the control site (ARTCC) through the control adapter which will indicate that the equipment is ready to use.

1-3.4.3.4 Local control.- Local control of the transceiver shall be included. This shall be accomplished by thumb-wheel switching wherein direct indication of frequency is applied. Push-to-talk arrangements shall be included on the transceiver.

1-3.4.4 Control adapter requirements.- This section of the specification contains those requirements which are applicable to the control adapter portion of the transceiver.

1-3.4.4.1 General.- The control adapter shall provide all interface between the four-wire line (1-3.2.17) and the transceiver including its synthesizer for all control signals.

1-3.4.4.2 Functions.- The control adapter shall be used primarily for conversion of all serial digital input signals to those required by the transceiver and its synthesizer for activation of all commands.

1-3.4.4.3 Error check.- The control adapter, or the synthesizer, shall examine each received word or message or both to assure reception with legitimate coding. When incorrect, further selection shall stop and indication of improper coding shall be returned to the control site (ARTCC) over the fail-safe system (1-3.4.3.2.2 and 1-3.4.3.2.2.1). As a minimum requirement for frequency coding, VHF selection shall discard any frequency selection starting with 2 or 3, while UHF selection shall discard any frequency selection starting with 1 or any number greater than 3.

1-3.4.4.4 Control adapter input.- Input to the control adapter shall be arranged to be received over a voice grade line (1-3.2.17).

1-3.4.4.4.1 Input level.- The control adapter shall operate without error or loss of control over all input signals of the transmitter (1-3.4.2.21) with (S+N)/N equal to or greater than 6 dB.

1-3.4.4.4.2 Bit rate.- The control adapter shall operate without error or loss of control at a bit rate of 150 bits per second.

1-3.4.4.4.3 Command functions.- The control adapter shall decode and provide outputs to the transceiver and its synthesizer which will activate the following command functions. Message structure is defined in figure 6. The message shall be made up of three tones: 1500, 1800, and 2100 Hz ±50 Hz.

Command	Reference paragraph
Sync	1-3.4.4.4.3.1
Attention	1-3.4.4.4.3.2
Tune command	1-3.4.4.4.3.3
Fail-to-tune	1-3.4.4.4.3.4, 1-3.4.3.2.2
Ready	1-3.4.4.4.3.5
PTT and release	1-3.4.4.4.3.6, 1-3.4.4.4.3.7
Reset	1-3.4.4.4.3.8

1-3.4.4.4.3.1 Sync.- Receipt of the sync signal shall set the clock timing function for the synthesizer (1800 Hz, 6 cycles/bit).

1-3.4.4.4.3.2 Attention.- Receipt of the attention signal shall initiate turn-on for the rest of the transceiver and its synthesizer (3 bits of 1800 Hz, 6 cycles/bit).

1-3.4.4.4.3.3 Tune command.- Receipt of the tune word shall set the synthesizer to provide the requested channel frequency and shall set up all passive circuits to optimum setting on that channel (1500 Hz, 5 cycles/bit followed by 1800 Hz, 6 cycles/bit).

1-3.4.4.4.3.4 Fail-to-tune.- The fail-to-tune (non-operative) signal shall be generated in the control adapter and returned to the control site (ARTCC) for further processing in the automatic control equipment. It shall be a 900 Hz ±50 Hz tone. A maximum of 10 ms shall occur between the fail-to-tune

lock action in the synthesizer and the transmission of this signal to the ARTCC via the control adapter. Neither this nor the ready signal shall be heard by the controller.

1-3.4.4.4.3.5 Ready.- When the synthesizer is locked on channel, the controller adapter shall generate a signal to the control system at the ARTCC which will notify the controller that the equipment is in standby condition ready for him to use (1800 ±10 Hz).

1-3.4.4.4.3.6 Push-to-talk.- The 2423 Hz (±10 Hz) tone received for PTT shall activate all circuits of the transceiver necessary to cause transmitter operation such as antenna relay operation, power application, receiver muting, synthesizer frequency switching, and other pertinent functions within 240 ms.

1-3.4.4.4.3.7 PTT release.- PTT release shall return the transceiver to receive condition within 240 ms.

1-3.4.4.4.3.8 Reset.- The reset message shall cause all functions of the transceiver to return to the idle condition with the transceiver and its synthesizer shut down awaiting another complete command message to place it again in operation in receive condition. This function shall not require more than 100 ms to complete.

1-3.4.4.5 Time required to activate receiver.- The transceiver shall be ready to operate in the receive mode (return ready tone) in not more than 0.5 second.

1-3.4.4.6 Control adapter output signals.- Output control signals (fail-to-tune and ready) shall be provided to the voice grade line at the same level as the receiver's audio output (1-3.4.1.12).

1-3.4.4.7 Parity bit.- A parity bit is a "1" frequency or a "0" frequency, whichever is required, to produce an odd number of "1" frequency bits, including the parity bit positions used for frequency selection.

1-4. QUALITY ASSURANCE PROVISIONS

1-4.1 General.- The contractor shall establish and maintain a quality control program in accordance with FAA-STD-013. The quality assurance provisions specified in section 1-4 of FAA-G-2100/1 form a part of this specification. When both VHF and UHF transceivers are ordered, the total number of type tests shall be scheduled on the basis of the total quantity of transceivers ordered (1-4.3.3.1 of FAA-G-2100/1). As herinafter specified, type and production tests shall be conducted on frequencies in both the VHF and UHF bands to demonstrate full-band capability for each, except that temperature and humidity tests need not be conducted on more than one frequency for each transceiver.

1-4.1.1 Classification of tests.- Tests are designated regarding class per 1-4.3 of FAA-G-2100/1 as follows:

(a) Design qualification D

(b) Type T

(c) Production P

1-4.1.2 System compatibility.- The contractor shall conduct a system compatibility test at a site specified by the Government. It shall prove the unit's ability to tune, reset, transmit, and receive in the FAA system (1-3.3.1.7). Specified tests are as follows:

(a) All control signals

(b) Transmit voice and 1 kHz tone across the band

(c) Receive voice and 1 kHz tone across the band

(d) Undesired control signals during operation

1-4.2 Procedures and test equipment

1-4.2.1 Test procedures.- The test procedures given herewith, including the specified test equipment and corresponding figures, are intended for the receiver with normal bandwidth. Where channel frequencies 118, 127, and 131 MHz are specified for the VHF receiver, channel frequencies of 225, 300, and 400 MHz shall be substituted for the UHF receiver and the undesired test signal levels and spacing for the receiver shall be tabulated.

1-4.2.2 Signal generator usage.- The requirements of tests can be met using standard models of signal generators, by proper use of accessory pads, cables, etc., provided attention is given to the signal output circuits and the relation of terminal voltages to calibrated voltages. The following paragraphs discuss examples of signal generator application under various conditions.

1-4.2.2.1 Type A signal generator.- The Type A signal generator has an internal impedence equivalent to a 50-ohm resistor and provides an open circuit voltage at its output terminals equal to the calibrated voltage. When a receiver input is connected directly to such a signal generator, the requirements will be met when the attenuator dial is set to the calibrated voltage.

1-4.2.2.2 Type B signal generator.- The Type B signal generator also has the internal impedence of 50 ohms but provides an open circuit voltage as its output connector equal to twice the calibrated voltage. When a receiver is connected directly to this type of signal generator, the attenuator dial must be set to one-half the specified voltage in order to meet the requirements of this specification.

1-4.2.2.3 Connection of two signal generators.- The requirements for two generators can be met by using a network which, when connected to the two generators, will appear to the receiver connection point as a 50-ohm source with both generators connected; when the receiver input is replaced with a 50-ohm resistive load, one-half the specified voltage will appear across

this load. An example of the simplest case would be the use of two generators of the Type B connected to the receiver through three 16.66-ohm resistors in a symmetrical wye configuration, with the equipment grounds tied together.

1-4.3 Schedule of tests.- The frequency and line voltage designations indicated in the following tests are as follows:

Designation	Test Frequency
L	2nd step from low end
M	Middle step fo range
H	2nd step from high end

Thus, L means 118.025 MHz for VHF while it indicates 225.050 MHz for UHF.

Line Voltage Designation	Line Voltage (V AC)
L	105
R	120
Full range	105 to 130
H	130

1-4.3.1 Temperature and humidity tests.- The following tests shall be made while subjecting the equipment to the test procedure described under 1-4.12 of FAA-G-2100/1.

Class	Test	Line Voltage	Paragraph
T	Sensitivity	Full range	1-3.4.1.2
T	Selectivity, 6 dB and 60 dB points	R	1-3.4.1.3
T	Output stability	R	1-3.4.1.15.3
T	Carrier power output	R	1-3.4.2.12
T	Modulation percentage stability (0 dBm, 1 kHz, 90% modulation)	Full range	1-3.4.2.20.4
T	Output frequency accuracy and stability	Full range	1-3.4.2.6
T	Carrier control or modulation	Full range	1-3.4.2.5
D	Effect of temperature/humidity	R	1-3.4.2.13.1
D	Effect of line voltage variation	R	1-3.4.2.13.2
D	Frequency outputs (L, M, H)	R	1-3.4.3.1.1
D	Frequency accuracy (L, M, H)	R	1-3.4.3.2.3
D	Output level (L, M, H)	R	1-3.4.3.2.4
D	Spurious output (L, M, H)	R	1-3.4.3.2.4.1
D	Non-lock signal (L, M, H)	R	1-3.4.3.2.2.1
D	Ready signal (L, M, H)	R	1-3.4.3.3

1-4.3.2 Tests under normal test conditions.- The following tests shall be made under normal test conditions in a shielded test position.

Class	Test	Paragraph
P	Frequency range and remote tuning	1-1.2, 1-3.4.3.1.1, 1-3.4.4.4.3.3
T	Output circuit	1-3.4.1 thru 1-3.4.1.15
T	Output level regulation	1-3.4.1.15.1
T	Audio level vs. modulation	1-3.4.1.15.2
P	Sensitivity	1-3.4.1.2
P	AF gain control characteristics	1-3.4.1.13
T	Selectivity	1-3.4.1.3
P	Selectivity (6 and 60 dB points)	1-3.4.1.3
T	Passband characteristics	1-3.4.1.3.1
T	Undesired responses (300, 225, and 400 MHz)	1-3.4.1.4
P	Image response (225 and 400 MHz)	1-3.4.1.4
T	Desensitization (midband)	1-3.4.1.4.1
T	Cross modulation (400 MHz)	1-3.4.1.4.2
D	Input power	1-3.3.2.5.4
T	RF intermodulation	1-3.4.1.4.3
T	Hum and noise	1-3.4.1.14.2
T	Audio frequency response	1-3.4.1.14
P	Audio frequency response (400 Hz, 1 Hz, and 2.6 kHz)	1-3.4.1.14
T	Harmonic distortion	1-3.4.1.14.1
T	Automatic volume control	1-3.4.1.5
P	Automatic volume control	1-3.4.1.5
T	AVC time constant	1-3.4.1.5.1
T	Squelch	1-3.4.1.6
P	Squelch	1-3.4.1.6
P	Squelch differential	1-3.4.1.6.1
T	Squelch opening time	1-3.4.1.6.2
T	Squelch muting	1-3.4.1.6.3
T	Noise control	1-3.4.1.7
T	Conductance susceptibility	1-3.4.1.8
T	Mixer/synthesizer coupled output	1-3.4.1.9
T	Mixer/synthesizer interaction	1-3.4.1.10
P	Operational stability	1-3.4.1.17
T	RF input circuit protection	1-3.4.1.16.1
P	Fail-safe	1-3.4.3.2.2, 1-3.4.3.2.2.1
T	Spurious outputs	1-3.4.3.2.4.1
P	Spurious outputs	1-3.4.3.2.4.1
T	Fail-safe	1-3.4.3.2.2., 1-3.4.3.2.2.1

1-4.3.3 Tests under line voltage variation.- The following test shall be performed under normal test conditions, except that the AC-line voltage shall be as specified below.

Class	Test	Line Voltage	Paragraph
P	Carrier power output (118 MHz, 136 MHz, 225 MHz, 300 MHz and 400 MHz)	R	1-3.4.2.12
T	Carrier power output stability (139 MHz, 400 MHz)	H	1-3.4.2.13 thru 1-3.4.2.13.2
T	Carrier level variation (136 MHz, 400 MHz)	R	1-3.4.2.14

Class	Test	Line Voltage	Paragraph
P	Carrier noise (118 MHz, 136 MHz, 225 MHz, 400 MHz)	H	1-3.4.2.15
T	Harmonic and spurious output (118 MHz, 136 MHz, 225 MHz, 300 MHz, 400 MHz)	H	1-3.4.2.15.1
T	Undesired radiation level (118 MHz, 136 MHz, 225 MHz, 300 MHz, 400 MHz)	R	1-3.4.2.17
T	RF intermodulation (118 MHz, 136 MHz, 225 MHz, 300 MHz, 400 MHz)	R	1-3.4.2.18, 1-3.4.2.19
D	Modulator input impedence (300 Hz, 600 Hz, 1 kHz, 2 kHz, 3 kHz)	R	1-3.4.2.21.1.1
T	Modulation range (300 Hz, 1 kHz, 3 kHz, -25 dBm, 0 dBm, 136 MHz, 400 MHz)	R	1-3.4.2.20.3
P	Modulation range (1 kHz, 136 MHz, 400 MHz)	R	1-3.4.2.20.3
T	Modulation percentage stability (0 dBm, 1 kHz, 90% mod.; 136 MHz, 400 MHz)	full range	1-3.4.2.20.4
T	Audio response (100, 200, 300, 400, 500, 700 Hz; 1, 1.5, 2, 3, 4, 5, 7, 10 kHz; 136 MHz, 400 MHz)	R	1-3.4.2.21.2, 1-3.4.2.21.3
P	Audio response (150, 300 Hz; 1.3, 5, 10 kHz; 136 MHz, 400 MHz)	R	1-3.4.2.21.2
T	Audio distortion (300 Hz; 1, 3 kHz; -25 dBm, 0 dBm; 136 MHz, 400 MHz)	full range	1-3.4.2.21.3
P	Audio distortion (1 kHz; +10 dBm; 118 MHz, 136 MHz, 225 MHz, 400 MHz)	R	1-3.4.2.21.3
T	Hum distortion (-25 dBm, 1 kHz; 30% mod., 90% mod., 136 MHz, 400 MHz)	R	1-3.4.2.21.3.1
P	Parasitic and spurious oscillations (118 MHz, 136 MHz, 225 MHz, 400 MHz)	full range	1-3.4.2.2
P	Reserve excitation (136 MHz, 400 MHz)	R	1-3.4.2.3

1-4.3.4 Operating and heat test.- The design qualification test described below shall be conducted following step 6, and in lieu of steps 7 and 8, of the test procedures given in 1-4.3.3.2 of FAA-G-2100/1, on the first unit of equipment subjected to the temperature/humidity tests.

Step 6A — When all readings have been recorded at the end of Step 6, readjust the output power to 20 W, 90 percent modulation and then increase the line voltage at the upper limit. Continue to maintain the temperature at the maximum specified for the service conditions (or higher) and the relative humidity at 95% ±5%.

Step 6B — After 4 hours of continuous operation of the equipment, switch the transmitter carrier off and then on by keying at the rate of 10 times per minute. The keying duty cycle shall be approximately 50 percent on and 50 percent off. Continue this procedure for a second period of 4 hours.

Step 6C Reduce the line voltage to rated value, and continue operation with the on-off keying specified in step 6B at the prescribed ambient temperature and humidity for a final period of not less than 88 hours.

1-4.3.5 Driver input versus transceiver output.- The RF output at the transmitter output connector shall be measured and tabulated as the input power from the synthesizer is varied in increments from zero to maximum. From the data thus obtained, a characteristic curve shall be prepared and shall be included in the instruction book for use in estimating power amplifier RF output and power output with reference to synthesizer output.

1-4.3.6 Undesired radiation level tests.- In testing to demonstrate compliance with the requirements of paragraph 1-3.4.2.17, both the plane of polarization and the position of the test antenna relative to the transmitter and its external wiring shall be adjusted for maximum field strength indication. It will be permissible to conduct these tests in a shielded room, if desired, to minimize the masking effect of signals from other sources, but no shielding other than that of the transceiver itself shall be used in the vicinity of the test antenna which could change the field strength of the radiation being measured.

1-4.3.7 RF intermodulation tests.- In testing for compliance with measurement of the level of the interfering signal(s), measurement shall be made with a 50-ohm resistive load substituted for the transceiver. The interfering signal(s) shall be fed to the output connector in a manner which does not disturb the normal impedence relationship of the transceiver output circuit and dummy antenna load (50-ohms resistive).

1-4.3.8 Intermodulation measurement.- The device for measuring intermodulation product amplitude shall be designed and isolated from the transceiver output such that distortion and intermodulation within the device does not effect the intermodulation measurements.

1-4.3.9 Output circuit tests.- Using a load providing a voltage SWR of 3.0 at the transmitter output and a 50-ohm line continuously adjustable over at least a 360^{o} range of electrical length, determine the load conditions requiring extremes of adjustment of the transmitter output circuit controls. Use these load conditions for production tests to demonstrate the performance of the transmitter output circuit.

1-5. PREPARATION FOR DELIVERY

1-5.1 General.- The contractor shall package, ship, and deliver the equipment in accordance with MIL-E-17555, Level B, or as specified in the contract.

1-6. NOTES

1-6.1 Note on information items.- The contents of this section are only for the information of the initiator of the procurement request and are not a part of the requirements for this specification. They are not contract requirements nor binding on either the Government or the contractor. In order for these terms to become a part of the resulting contract they must be specifically incorporated into the schedule of the contract. Any reliance placed by the contractor on the information in these subparagraphs is wholly at the contractor's own risk.

1-6.2 Intended use.- The equipments are to be used in air route traffic control centers for emergency communications.

* * * * *

FOR FIGURES 1 TO 6, SEE PAGES 32 TO 38

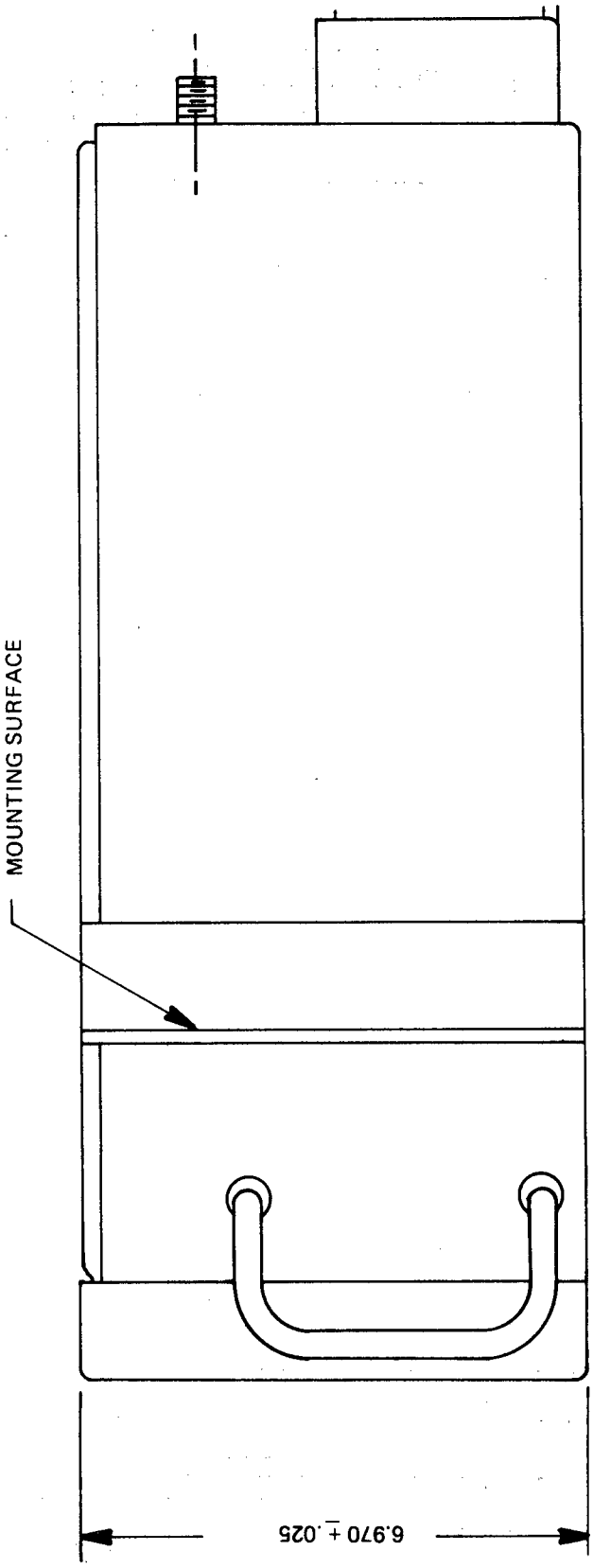


Figure 1. Assembly Side View

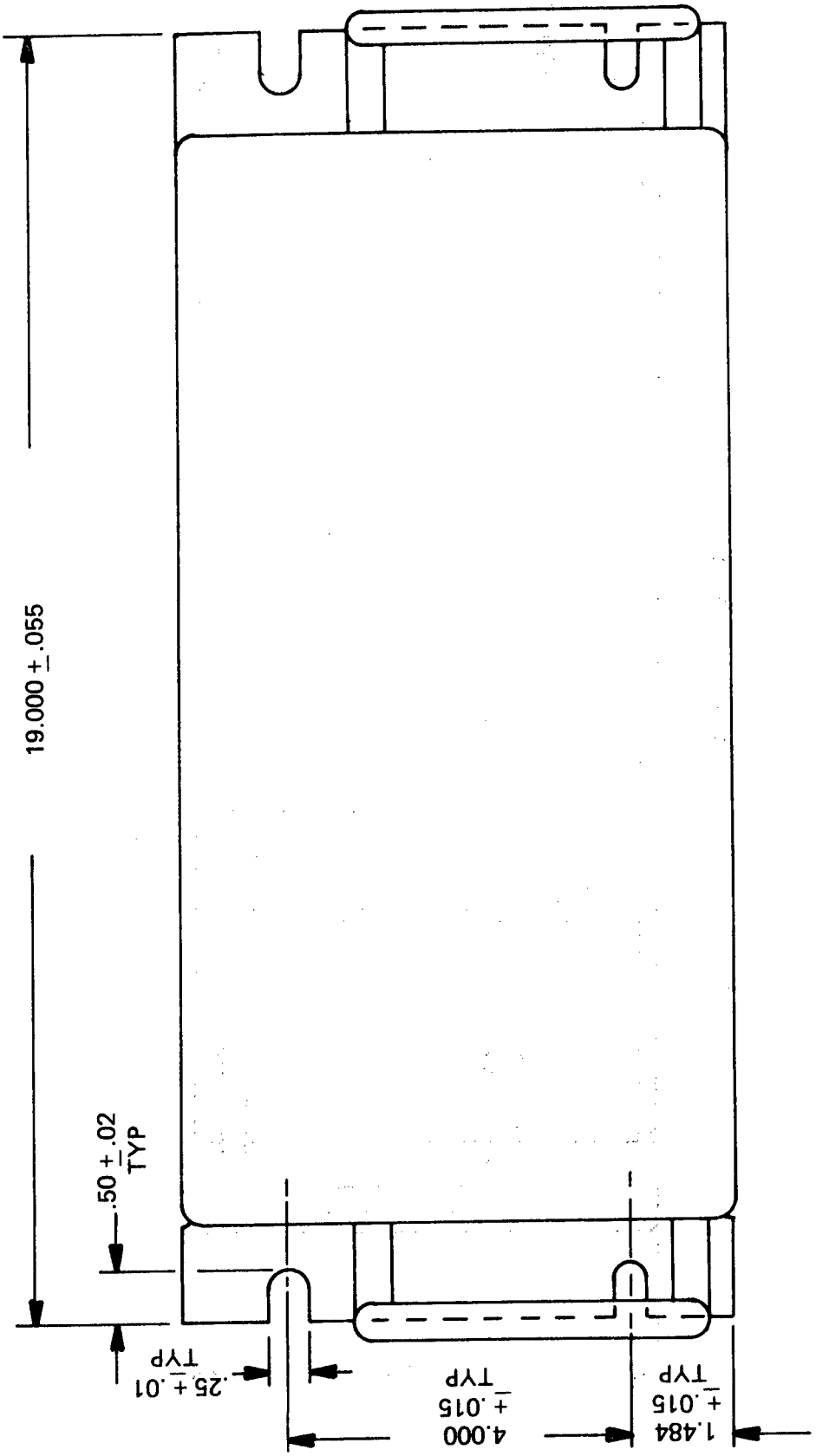


Figure 2. Assembly Front View

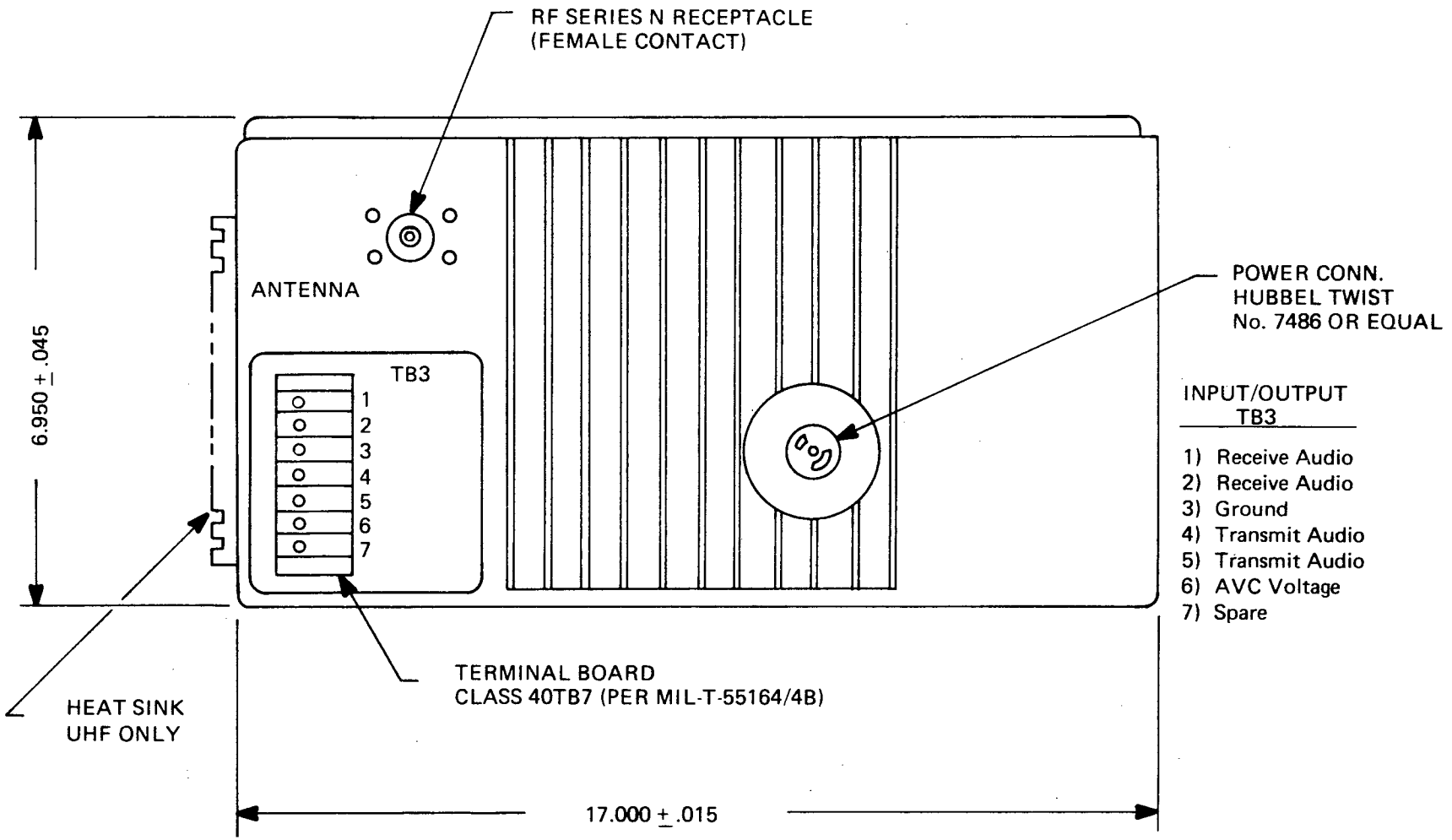


Figure 3 Assembly Rear View

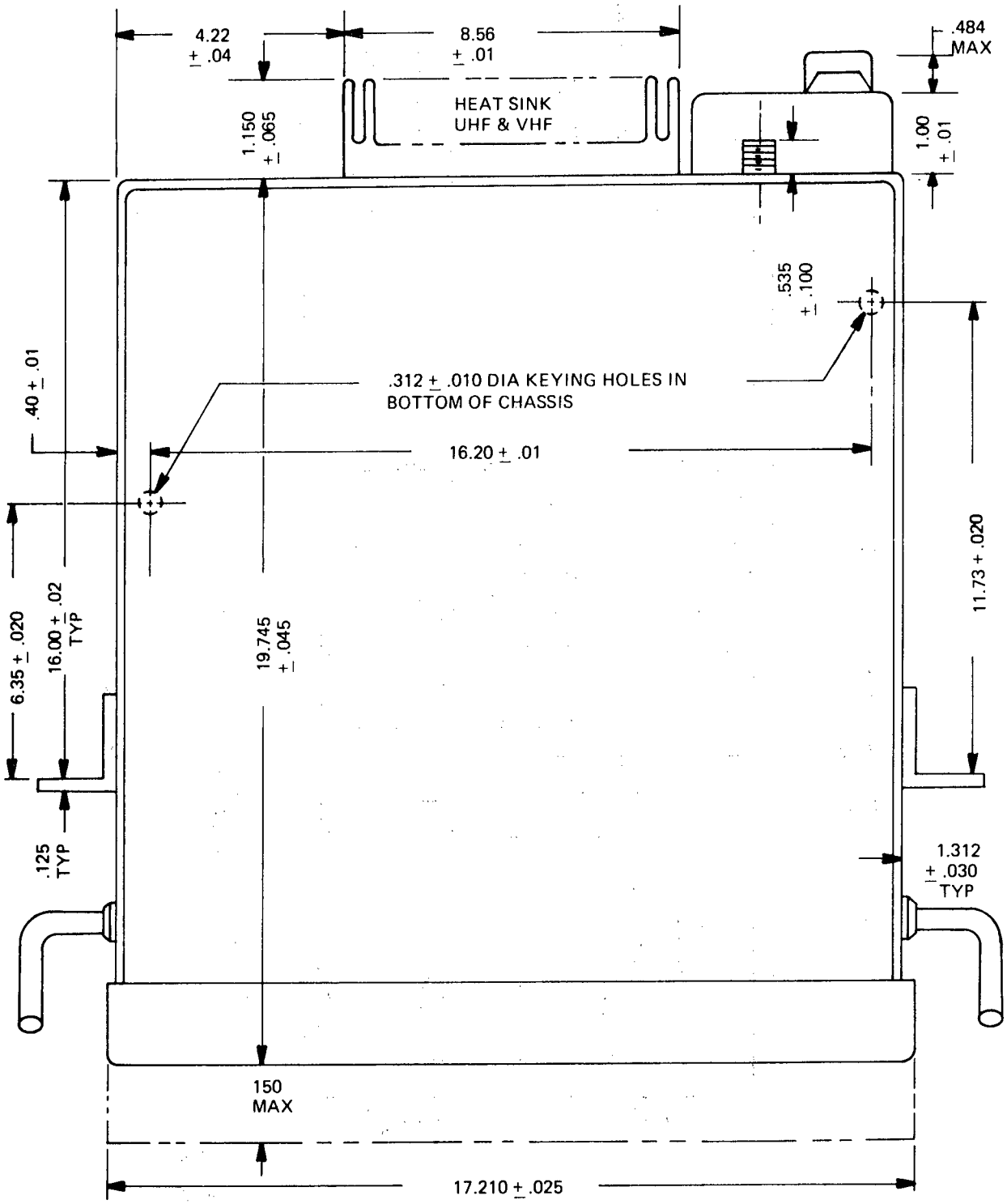
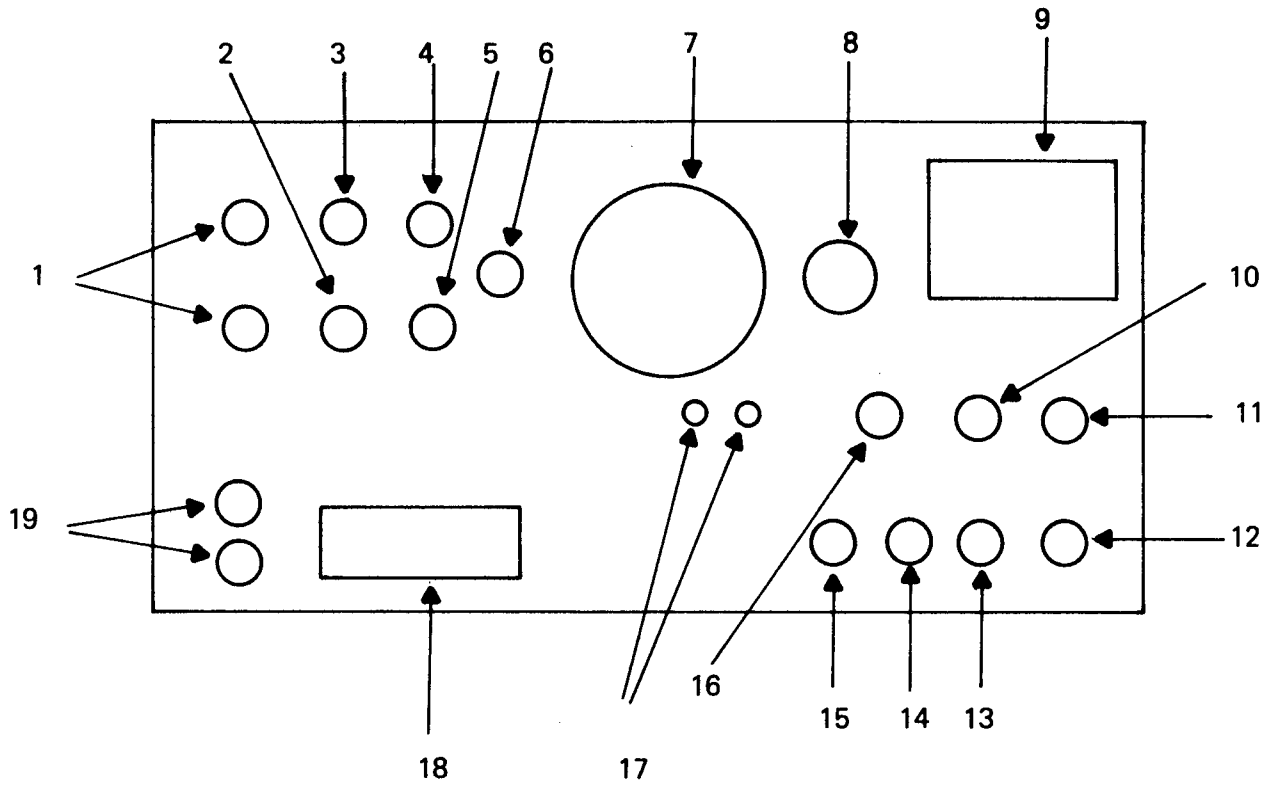


Figure 4. Assembly Plan View

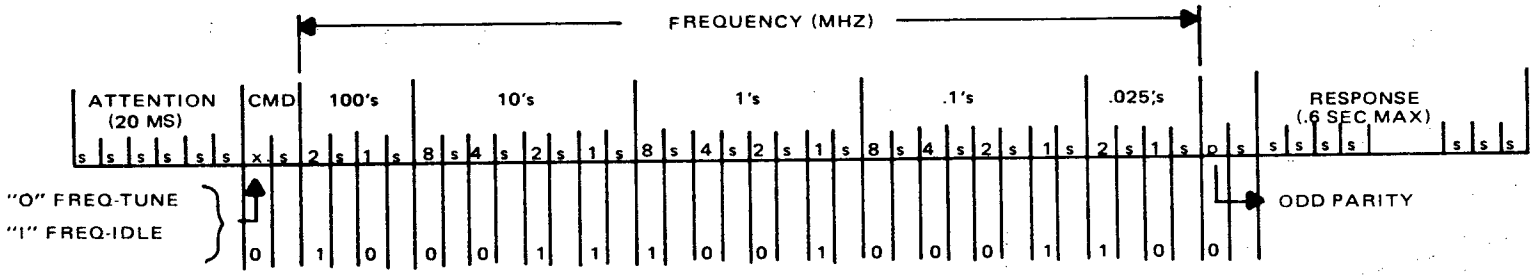


1. Synthesizer inputs, receiver and transmitter
2. Local power switch
3. Pilot light
4. Fuse
5. Fuse
6. Mode selector switch
7. Multimeter
8. Multimeter switch
9. Nameplate
10. Squelch adjustment
11. Audio frequency gain
12. Audio frequency output
13. Squelch switch
14. Microphone jack
15. Test key switch
16. Modulation adjustment
17. RF output sampling jacks
18. Frequency selector switches
19. Synthesizer outputs, receiver and transmitter

Figure 5. Front Panel Layout

"1" FREQ = 2100 Hz (7 cycles/bit)
"S" (SYNC) FREQ = 1800 Hz (6 cycles/bit)
"O" FREQ = 1500 Hz (5 cycles/bit)

Bit Period = 6.67 ms ("1" or "O" frequency plus following sync frequency
Bit Transfer Rate = 150 Hz



(NOTE: TO TUNE TO 239.150MHz THE "1's" AND "O's" WOULD APPEAR IN POSITIONS AS SHOWN)

Figure 6. Word Format

APPENDIX

TABLE OF CONTENTS

TABLE OF CONTENTS (Con.)